Conservation Innovation Grant (CIG)
Final Report
Strategically Reducing Phosphorous Excretions in Grazing Beef Cattle

Mark A. McCann
Animal and Poultry Sciences Department, Virginia Tech

Project time period: June 2011- March 2014

Proposal # 69-33A7-11-26

Date of submission: June 30, 2014

Deliverables- **1)** Assess phosphorus status and supplementation of 200 grazing beef cattle farms within the Chesapeake Bay watershed of Virginia.

2) Provide science based information to cattlemen to efficiently meet phosphorous requirements of grazing cattle while minimizing phosphorus excretion.

3) Present preliminary project results in winter production meetings and in a webinar.

4) Produce a technical note (NRCS format) summarizing project results and recommendations that can be used by NRCS to provide technical guidance to applicable beef cattle clients.

5) Produce a parallel Extension publication that can be used by Virginia Cooperative Extension to provide information and guidance to cattlemen.

6) Create a database tool (with written instructions for use) that can be used by local technical experts for developing phosphorus recommendations customized for individual farms or environmental conditions.

7) Provide a Joint Educational Development (JED) training session to participating NRCS and partner staff members (one JED in each of the four Areas of VA in 2012) summarizing the project, highlighting the technical note, and training participants on how to use the database to develop phosphorus recommendations for beef cattle farms.

8) Provide a parallel in-service training for ANR Extension agents in 2012.

9) Work with the feed and mineral manufacturers that service Virginia to update them on the results of the project and the importance of providing mineral supplements with lower phosphorus concentrations that can be utilized in production conditions and locations where phosphorus supplementation is not required.

10) Work with local cattlemen associations throughout VA who group purchase custom mineral supplements for members to incorporate the results from the project and lower P content in minerals whenever possible.

11) Submit semi-annual and annual reports to update status and progress towards the goals/objectives of the project.

12) Submit final report and recommendations to VA NRCS for statewide use and implementation of the findings of this project.

Table of Contents

Executive Summary- This project addressed the NRCS priority of benefitting the Chesapeake Bay water quality. The goals and objectives of the project were twofold: 1) to collect information and field samples from beef cattle farms in Virginia's Chesapeake Bay watershed related to phosphorus status and supplementation; and 2) conduct feeding demonstrations in a controlled environment where cattle phosphorus intake and excretion could be quantified and the information extrapolated to on-farm conditions reported from the field samples.

Steer feeding demonstrations indicated that increased phosphorus supplementation, both inorganic and organic sources, increased phosphorus excretion in a parallel fashion. Additionally, higher levels of phosphorus supplementation resulted in a greater percentage of excreted phosphorus in the inorganic or water soluble form. Seventy percent of the forage samples exceeded the phosphorus need of a beef cow at peak lactation and 99 % of the forage samples exceeded the late gestation and late lactation phosphorus requirement. These results indicate that reducing or eliminating phosphorus supplementation would reduce total and inorganic phosphorus excretion of grazing beef cattle while still meeting the cow's phosphorus requirement. Additionally, the farm collected fecal samples would also suggest that cattle are receiving phosphorus supplementation beyond their nutritional needs. The survey revealed that over 82% of the cattlemen would consider reducing their phosphorus supplementation if they were confident that forage was meeting their cattle's phosphorus requirement. The results did meet the goals and objectives of the project. However, the projected number of field samples (167 vs 200) was not realized. The difficulty in getting samples collected in a timely fashion impacted both the number of samples collected and the length of time to acquire a significant number. These two factors were major causes for the time extension from September, 2012 to March, 2014. Although the time needed for the project was underestimated, no major funding issues arose and funds were expended in budgeted areas.

The Chesapeake Bay and cattlemen are both potential benefactors from the project. Reduced phosphorus supplementation should result in decreased phosphorus excretion and reduced importation of phosphorus into the bay watershed. Additionally, there is an economic incentive for cattlemen to reduce phosphorus levels in their free-choice minerals because it is one of the more costly elements to add to a free-choice mineral. Low or zero level phosphorus minerals are available at lower costs as compared to those that contain higher levels. Unfortunately, cattlemen must check the mineral analysis content to insure that while phosphorus is lower; that other important trace elements are at the recommended level. Many cattle groups in Virginia group purchase custom formulated minerals, and it is hoped that these groups will adopt low phosphorus minerals. To date three cattle groups have adopted this approach. In an effort to have low and zero phosphorus options available to cattlemen. The results have been shared with one regional cooperative and a multi-state cooperative.

Currently there is no Federal, State or local programs in place to implement these results. However, forage analyses are conducted by local extension agents in educational programming and by advanced producers. It would be beneficial if they would expand their evaluation of forage nutritive content to include phosphorus.

The major recommendation of the project would be to lower the phosphorus content of minerals being fed to cattle. The majority of farms were found to have forages at or above phosphorus levels needed. Fecal and or forage analysis can confirm the change.

Introduction- The project was led by Mark McCann, Beef Extension Specialist at Virginia Tech, who has over 25 years of experience working in forages and beef cattle nutrition and forage. The participation in the field sampling was available to all cattlemen in the Virginia Chesapeake Bay watershed counties. Announcement of the opportunity was announced to county agents and cattlemen through the Extension Livestock newsletter and the Virginia Cattleman monthly paper.

The objective of the project was to assess current phosphorous supplement practices of grazing beef cattle in the Chesapeake Bay watershed counties of Virginia.

1) Provide a science-based foundation to cattlemen to efficiently meet phosphorous requirements of grazing cattle while minimizing phosphorous excretion.
2) Build a database where management practices and cattle nutritional requirements can be incorporated into P recommendations that can be customized to an individual farm or environmental conditions.
3) Share recommendations with cattlemen, local technical experts (NRCS, SWCD, Extension) and the feed industry in an effort to highlight herd and farm P importation on a holistic scale.

NRCS provided a $30,000 CIG grant towards this project. The Virginia Agricultural Council ($15,000) and Virginia Tech (in-kind) provided the matching funds. A key relationship that facilitated the project was one formed with Dr. Katherine Knowlton in Dairy Science Department at Virginia Tech. Earlier, Dr. Knowlton and colleagues in Dairy Science had conducted a large scale project to reduce phosphorus excretions in dairy cows. Her advice and insight were invaluable, and we were also able to use her laboratory to determine total and inorganic phosphorus.

Background- Phosphorous supplementation of grazing beef cows is a commonly recommended and accepted management practice. Deficient phosphorus intake levels have been reported to negatively impact cow reproduction rates. In an environment of inexpensive phosphorus, the level of supplementation often exceeded the requirement to provide reproductive insurance. Recent increases in phosphorus costs have removed the low cost factor, but cattlemen are ingrained with the concept of phosphorus and bovine reproduction.

The draft TMDL proposal by EPA for the Chesapeake Bay outlines significant reductions in target loads for sediment, nitrogen and phosphorous. These proposed targets will likely lead to heightened future scrutiny of agriculture's contribution in the bay watershed as one of the contributing sources. The regulation of animal production in the watershed has historically focused on concentrated animal feeding operations (CAFOs). New TMDL reduction targets will likely expand the scope of non-point source pollution control efforts to include grazing beef cattle. Over 50% of Virginia's 650,000 beef cows are located in the bay watershed counties. If cows in the Virginia watershed receive the recommended 4 ounces/d of a free-choice mineral containing 6% phosphorous, 1100 tons of phosphorus is imported into these counties on a yearly basis. This amount of imported phosphorus is similar to Virginia's 2015 reduction target and approximately a third of Virginia's 2025 phosphorus reduction target.

Educating cattlemen on the status of phosphorus in their soils and forages as compared to the needs of their cattle over stages of production will allow a more efficient, economical and environment-friendly means of meeting their cow's phosphorus requirements. The impact of commonly fed corn byproducts, such as distiller's grains and corn gluten feed which are all high in phosphorus, will also be highlighted in the context of total phosphorus to the farm and beef herd. Phosphorous is also one of the more expensive components of a mineral mix. Reducing phosphorus content of mineral mixes has the added benefit of potentially lowering the cost of mineral supplements. An additional key audience beyond the farm gate is the feed industry which formulates beef cattle mineral supplements. Greater variety in phosphorus levels in mineral supplements available to cattlemen will be necessary to meet their herd's phosphorus requirement without overfeeding.

Currently, recommendations to reduce nonpoint pollution from grazing beef cattle focus on structural and operational solutions, such as stream exclusion, alternate water sources, grazing management and steam crossings. Of the main contributors to nonpoint source (nitrogen, phosphorous and bacteria) pollution from the grazing beef animal, phosphorous could hold a different solution. Removal of phosphorous from the mineral supplements of Holstein steers grazing Wisconsin pastures had no negative impact on daily gain (Brokman et al., 2008). When phosphorous was added to the supplement, fecal phosphorous excretion increased. Subsequent forage analysis confirmed that grazed forage in the trial was adequate for growing steers. Analysis of over 600 grass hay samples produced in Virginia in 2006 revealed a ten-fold variation in phosphorus content (0.6-6.0%). The phosphorus requirement of mature beef cow varies 100% over the course of her production year (14-28g/d). Recent efforts in Virginia and other bay watershed states focused on dairy cattle have demonstrated that phosphorus supplementation can be decreased without detrimental effects on cow performance and reproduction.

Review of methods- The innovative element of the project addresses the potential contribution of grazing beef cattle to phosphorus in the Chesapeake Bay watershed. Currently grazing cattle are not monitored. The large number of cattle in Virginia's watershed counties (300,000+) provides the opportunity for small changes to have large impacts. A 6 g/head/day reduction in phosphorus supplementation translates into a 2 ton/day reduction of phosphorus imported into the bay watershed counties. Although forages are sometimes analyzed for this cattle population, mineral composition is often overlooked. Fecal analysis for phosphorus is not done on any grazing operation and is a fairly easy and economical process. The analytical laboratory (Cumberland Valley Analytical Services) used by Virginia Cooperative Extension for forage analysis also conducts fecal phosphorus analysis. The fecal sampling conducted over a wide range of dietary phosphorus levels in the feeding demonstrations allowed the development of a regression equation to predict diet phosphorus levels, which can then be compared to the documented phosphorus requirement. This regression tool was developed into a Farm Phosphorus worksheet/calculator for NRCS and Extension personnel.

Discussion of procedure and quality assurance-

Feeding demonstration 1 Eight Hereford steers, with an initial average body weight of 670 lbs, were randomly assigned one of four dietary phosphorus treatments. Dietary P levels were achieved by adding increasing levels of dicalcium phosphate (0 g, 33 g, 65 g, and 95 g) to a basal diet of 11lbs/d, chopped grass hay. The dicalcium phosphate was fed separately from the hay and mixed with 1.75 lb/d beet pulp, 0.50 lb/d rumen-protected fat supplement, and 20 g/d of a P-free trace mineral salt. Dietary phosphorus intake was calculated to equal 50, 100, 150, and 200% of the daily dietary requirement of growing beef steers. The steers were housed individually and fitted with total fecal collection bags that were emptied and changed twice daily. During this study, there were a total of 4 periods with each steer receiving a different dietary treatment each period. Steers were adjusted to each diet for 9-d followed by a 5-d collection period. Feed and fecal samples were dried, ground, subsampled and analyzed for inorganic and total phosphorus.

Daily Dietary Offering						
Diet	**Dicalcium Phosphate (g)**	**Fat (lb)**	**Beet Pulp (lb)**	**Salt (g)**	**Low P Grass Hay (lb)**	**P (g)**
Diet 0	0	0.5	1.75	20.00	11	6
Diet 1	33	0.5	1.75	20.00	11	12
Diet 2	65	0.5	1.75	20.00	11	18
Diet 3	95	0.5	1.75	20.00	11	24

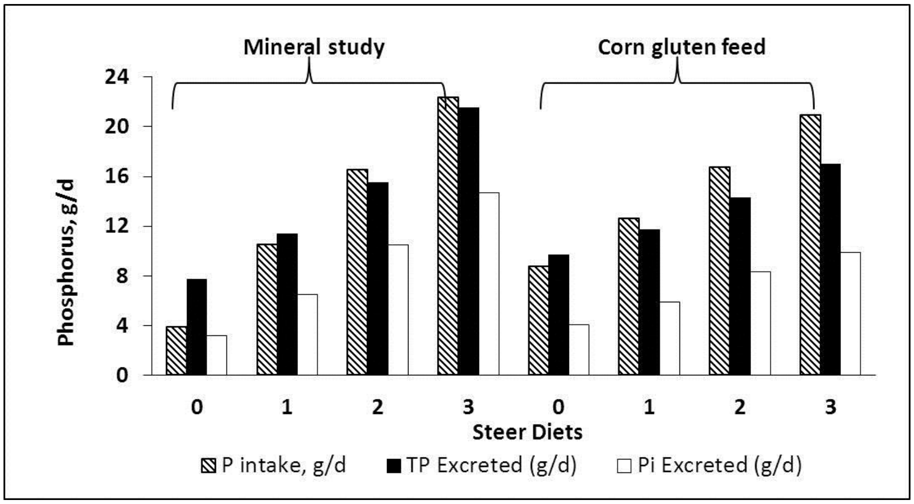
Feeding demonstration 2 Eight Hereford steers, with an average body weight of 941 lbs, were randomly assigned to one of four dietary treatments. Steers were fed a basal diet of chopped grass hay (0.13% P) and 0, 1.1, 2.2 or 3.3 lb/d of dried corn gluten feed pellets. All steers were supplemented with 2.0 lb/d beet pulp, 1.0 lb/d rumen-inert fat supplement and 18 g/d trace mineral salt. Urea was added to the respective diets at levels of 95, 72, 49, and 31 g/d to ensure equal dietary protein across treatments. Steers were housed individually and fitted with total fecal collection bags. Steers were adjusted to each diet for 9-d followed by a 5-d collection period. Feed and fecal samples were dried, ground, subsampled and analyzed for inorganic and total P.

Daily Dietary Offering							
Diet	**Corn Gluten Feed (lb)**	**Urea (g)**	**Fat (lb)**	**Beet Pulp (lb)**	**Salt (g)**	**Low P Grass Hay (lb)**	**P (g)**
Diet 0	0.0	95	1.0	2.0	18	15.7	10
Diet 1	1.1	72	1.0	2.0	18	15.7	14
Diet 2	2.2	49	1.0	2.0	18	15.7	18
Diet 3	3.3	31	1.0	2.0	18	15.7	22

The feeding study data was recorded and analyzed by graduates advised by the Principle Investigator. Forage samples were collected at the county level and sent to Cumberland Valley Analytical Services for analysis. Soil samples were submitted to and analyzed by the Virginia Cooperative Extension Soil Lab by county extension personnel.

Findings- The feeding demonstrations indicated that as greater amounts of phosphorus were fed, greater amounts were excreted via the feces. This relationship held true regardless of the source of phosphorus (mineral vs corn gluten). Additionally, as greater amounts of phosphorus were fed and excreted, the fraction of inorganic phosphorus excreted in the feces also increased (figure 1). This would suggest that as the amount of phosphorus supplemented exceeds cattle requirements, the amount of inorganic or water soluble phosphorus excreted also increases. The net result of feeding phosphorus above cattle nutrient needs is that a greater amount of phosphorus is excreted and a larger portion of the excreted phosphorus is in a form more vulnerable to runoff.

Figure 1. Phosphorus intake and excretion as influenced by amount of supplemental P



Samples collected from participating farms included soil, forage and fecal samples, a questionnaire regarding fertilization and supplementation practices and a tag from their free-choice mineral. Forage samples were analyzed for nutrient and mineral analysis. One hundred twenty locations from 11 counties participated with sample collection (N = 167). Sixty seven producers completed the survey instrument in addition to the full complement of forage and fecal samples.

Figure 2 displays the percentage of soil samples in each of the Virginia Cooperative Extension soil phosphorus classification levels. The smaller percentages of samples were in the low and very high categories, while over 70% of the collected samples were in the medium and high classification. The distribution of Forage phosphorus content is displayed in Figure 3. The overall average Forage phosphorus content was 0.34 % of DM. It should be noted that the average Forage P of the field samples exceeded the P requirement of all stages of production. While there were farms which needed P supplementation, they were the exception rather than the rule. Figure 4 depicts Soil and Forage phosphorus from each farm and the phosphorus requirement of a beef cow at peak lactation is super imposed. It is clear that the majority of forage samples collected exceed a beef cow's greatest phosphorus requirement. There is a general trend for increased Forage phosphorus levels as Soil phosphorus increases, but the relationship is not as strong as one might expect. Soil pH, forage maturity and rainfall also influence Forage phosphorus. In general Soil phosphorus was only a fair indicator of the Forage phosphorus level.

Figure 2. Soil P categories (135 samples)

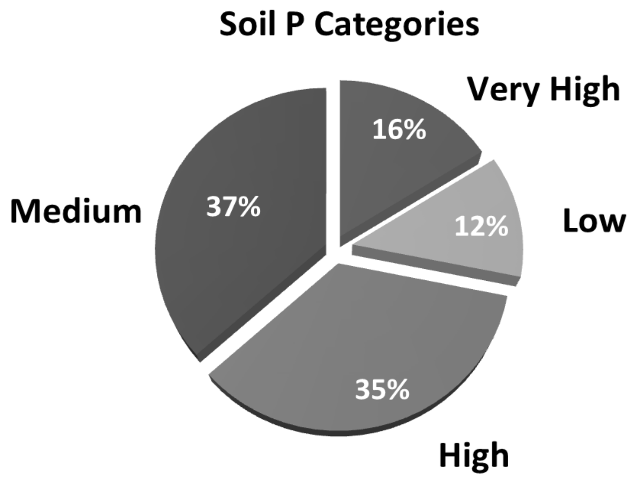


Figure 3. Forage P levels (168 samples)

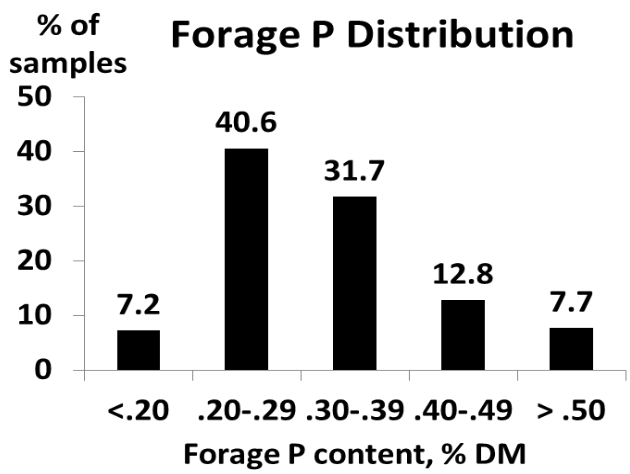
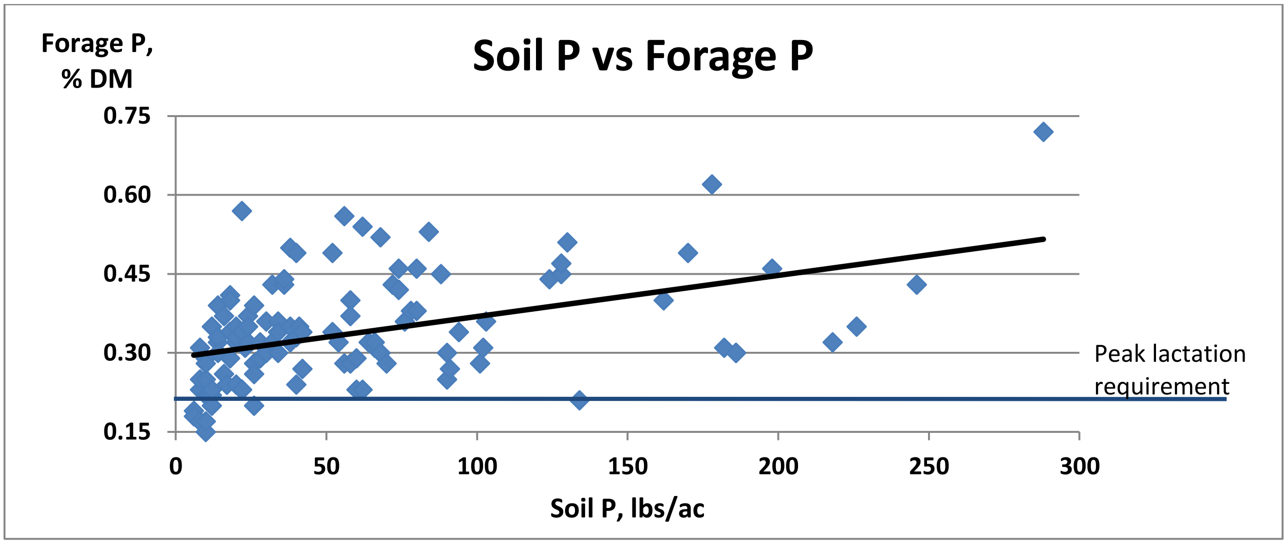
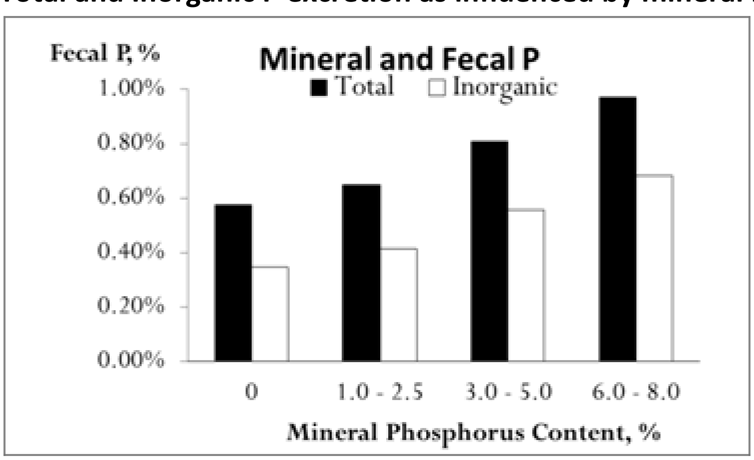


Figure 4. Relationship between Soil P and Forage P



Cattlemen who participated in the study also submitted feed tags of the free-choice mineral they were feeding. Farm mineral supplements were categorized into four levels of phosphorus content (0, 1.0-2.5, 3.0-5.0, and > 6.0 %). Mineral phosphorus content was unrelated to forage or hay phosphorus content on the farm. In fact, the average forage phosphorus content from the farms for the 0, 1-2.5, 3-5 and 6-8 % mineral categories was 0.27, 0.37, 0.37 and 0.46 %, respectively. This would suggest that farms offering minerals with higher phosphorus levels had a pasture or hay forage which was already high in phosphorus and required no supplementation. Fecal samples collected were analyzed for total and inorganic phosphorus. Results are plotted against the mineral phosphorus level in Figure 5. As the phosphorus content of the free-choice mineral increased, the total phosphorus concentration of the feces also increased. Also, as the fecal Total phosphorus increased, a greater percentage of it was in the inorganic form. This is characteristic of phosphorus excretion on diets which exceed the animal's requirement. The inorganic form of phosphorus is water soluble and provides a greater runoff risk.

Figure 5. Total and Inorganic P excretion as influenced by mineral P content



Two feeding demonstrations with growing beef steers allowed examination of the relationship between phosphorus concentration in the feed consumed and the inorganic phosphorus content of the feces (Figure 6). The impact of varying levels of dietary phosphorus intake on P_i excretion was similar for both trials and the data has been combined. Approximately 75% of the variation in inorganic phosphorus excretion is explained by the level of dietary phosphorus that was consumed by the steers regardless of form. This relationship can be used to estimate diet phosphorus content based on the inorganic phosphorus fecal content. Figure 7 contains the estimated diet phosphorus content from the 167 field study fecal samples based on the regression equation from Figure 6. Dietary phosphorus requirement of a beef cow at different production stages is superimposed in the figure. The results are similar to the conclusion based on Forage phosphorus alone. The majority of the samples met the phosphorus requirement across all stages of production.

Figure 6. Phosphorus intake vs fecal inorganic phosphorus

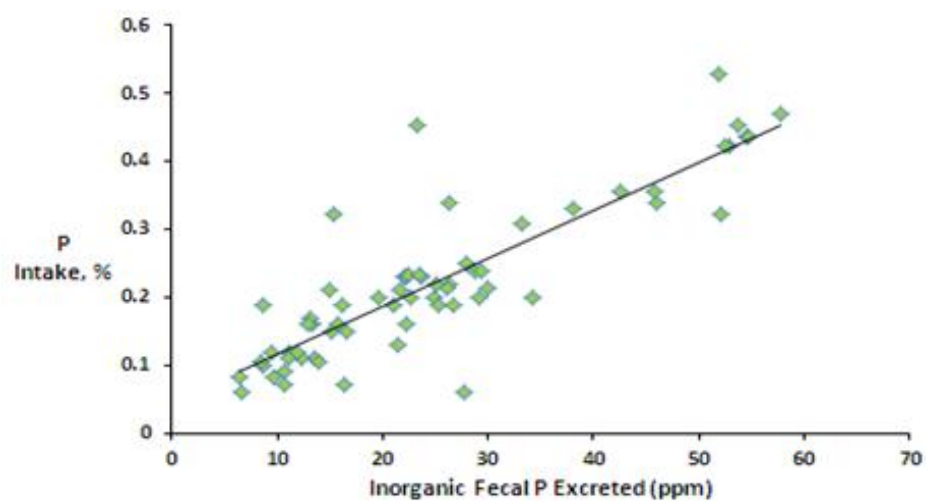
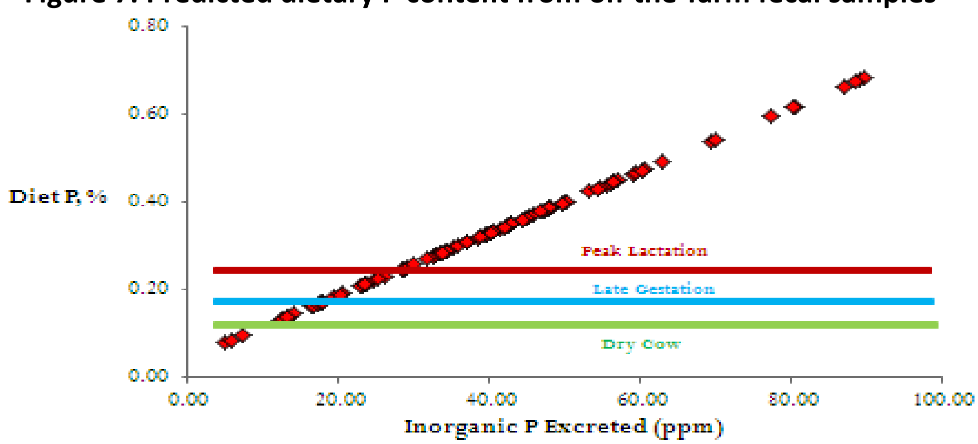


Figure 7. Predicted dietary P content from on-the-farm fecal samples



Sixty-seven producers completed the survey in addition to submitting soil and forage samples. Nutrient management plans (NMP) are a tool used to minimize whole farm environmental impact and enhance nutrient conservation on the farm by limiting soil erosion and runoff. Fifty-five percent of participants had implemented NMP at the time of survey completion. In relation, twenty-five percent of all producers sampled forage to determine nutrient content. The majority of producers that sampled forage (94 %) currently utilized nutrient management plans. Participants ranked criteria for mineral supplement selection. Responses were weighted based upon participant designated ordinal ranking of criteria (3 for primary, 2 for secondary and 1 for tertiary criteria). Interpretation of response distribution suggests that the primary criterion for mineral supplement selection was price (20.6 %), followed by local availability (17.8 %) and trace mineral content (17.5 %). Sixty-nine percent of producers supplemented a commercial complete mineral mix and 22% used a trace mineral salt block. Eighty two percent of participants indicated willingness to reduce mineral phosphorus supplementation levels if forage analyses revealed that feed and forage resources were capable of meeting phosphorus requirements, while 15 % indicated uncertainty, and 3 % indicated unwillingness.

Conclusions and Recommendations- Three basic questions need to be addressed to determine the phosphorus status of beef cattle and decide if and how much supplementation is warranted.

1) Soil samples and forage samples are the most logical place to start to determine a farm's phosphorus status. Soil levels provide a foundation of the amount of phosphorus that is available for plant growth. Soil content at the medium level (12-35 lbs/ac) will not require additional phosphorus and should not limit forage phosphorus content. Hay production will remove phosphorus and hay fields could need additional fertilization to stay at the medium level.

2) Forage phosphorus levels are the best gauge in determining which level of phosphorus to include in a free-choice mineral. Fresh forage and hay sample should both be sampled to represent grazed and stored forage. Lab results can be compared to the phosphorus requirements to determine if supplementation is needed. If a supplement is being fed, the phosphorus content of the supplement needs to be considered in conjunction with the forage.

3) A fecal analysis for total and inorganic phosphorus will allow for the best status estimate of phosphorus status of the animal because it is affected by sum of forage, mineral and any supplemental feed phosphorus. Laboratory results can be inserted into farm phosphorus worksheet to predict total diet phosphorus content.

In conclusion, phosphorus status of our waterways is affected by agricultural and non-agricultural activities in the watershed. Overfeeding phosphorus to beef cattle simply leads to greater fecal phosphorus excretion, much of which is in the higher risk, inorganic form. Through a combination of monitoring forage phosphorus content and selecting the correct mineral, fecal phosphorus excretion can be minimized at both an environmental and economic benefit.

Appendix I

County ____________ Virginia Beef Cattle Phosphorus Survey

1. How many head of beef cattle are at your farm today for each of the following categories?

   _____________ Beef cows (that have calved during the past year)

   _____________ Replacement heifers (weaned-pregnant)

   _____________ Other beef cattle (bulls, stockers)

2. Acreage committed to: (estimates)

   Pasture only ________ Hay only ________ Crop/grazing ________

   Hay + Pasture ________ Silage ________

3. What is your calving season? (check one)

   ____ Fall (Sep- Dec) ____ Fall & spring

   ____ Spring (Jan- Apr) ____ No defined season

4. What is the primary forage for the cow herd in the winter months? (Circle one).

   Hay Silage/baleage Pasture

   Other/combination (Please explain) _________________________

5. On average, how many days annually do you plan to feed harvested feeds to your cows? _______day/year

6. Do you sample your harvested feeds for a forage analysis? (Circle one) Yes No

   If yes, what management decisions are affected by the results ___________________________

7. Do you purchase any harvested feed for the cow herd? (Circle one) Yes No

   If yes, what percent of herd's need was met with purchased forage? _____

8. Have you fertilized any pastures during the past twelve months? (Circle one) Yes No

   If yes; to what percent of pasture were nutrients applied _____%

   What was the nutrient source?

   Commercial fertilizer, analysis ____-____-____; lbs/acre______

   Manure application, analysis (if known) ____-____-____; lbs/acre_____

   Biosolid application, analysis ____-____-____; lb/acre ______

9. Have you fertilized any hayfields or croplands from which you harvest forage for winter feed during the past twelve months? (Circle one) Yes No

   If yes; to what percent of hayfields or croplands was nutrients applied _____%

   What was the nutrient source?

   Commercial fertilizer, analysis ____-____-____; lbs/acre______

   Manure application, analysis (if known) ____-____-____; lbs/acre_____

   Biosolid application, analysis ____-____-____; lb/acre ______

10. Which supplement feeding practice best describes your management?
    A. Corn or other grain ___________
    B. Corn gluten feed
    C. Soyhulls
    D. Protein block
    E. Liquid feed
    F. Commercial supplement (ex. 14% supplement)
    G. Commodity pellet
    H. Other supplement/home mix____________________

11. How much supplement do you typically provide to your cow herd (lbs. /cow) on an annual basis?
    ____________ lbs /cow/year

12. What is your mineral supplement for the cow herd? (circle one)
    Plain salt block
    Loose white salt
    Home mineral mixture
    Trace mineral salt block
    Loose trace mineral salt
    Commercial complete mineral mix

13. Do you provide a high magnesium(>10%) mineral mix to the cow herd at any time?
    No ___ Yes ____ , if yes # months fed _____ (1-12)

14. How do you store purchased feed? (circle one)
    Commodity shed
    Grain bin
    Bags
    Other __________

15. Who is your primary source of nutrition advice? (circle one)
    Neighbors/ other cattlemen
    NRCS personnel
    Extension agent/specialist
    Local cooperative/feed store
    Veterinarian
    Other ________________

16. Please rank the **top three** factors in selecting a free-choice mineral (1,2,3).

Local availability	_____	Ca/P content	_____
Past experience	_____	Trace mineral content	_____
Palatability	_____	Vitamin content	_____
Price	_____	Ionophore/antibiotic inclusion	_____

17. Source of purchased mineral supplements. Please circle most appropriate answer.
    Local cooperative/ feed store
    Dealer/ company representative
    Local Cattlemen's Association
    Other ___________________

18. Does your farm have a formal nutrient management plan? (circle one)
    A. Yes how many years? ____
    B. No

19. Have you implemented any of the following management practices? (check all that apply)
    ____ Stream exclusion
    ____ Alternate water sources
    ____ Stream crossing
    ____ Unroll hay when feeding
    ____ Tarp or barn storage rolls of hay
    ____ Rotational grazing
    ____ Stockpiling fescue
    ____ Winter feeding areas
    ____ Stream/riparian installation
    ____ Addition of clovers to pastures

20. If forage analysis revealed that feed and forage adequately met the cow phosphorus requirement, would you feel comfortable in reducing the P content of the minerals you provide? (circle one)

    Yes No Maybe

Appendix II

Beef Cattle Phosphorus Worksheet

Farm Name/ Owner ______________________ County ______________________

Soil P, lb/acre __________

Forage P,% __________

Mineral P, % __________

Phosphorus Dietary Requirements

beef cow		% P	Stockers		%P
	Late gestation	0.16		1.0 lb/d	.19-.21
	Early lactation	.20-.23		2.0 lb/d	.21-.26
	Late lactation	.15-.17		3.0 lb/d	.26-.37
	Dry	0.13			

	Fecal inorganic P, ppm	Estimated dietary P content, %
	10	0.12
	20	0.19
	30	0.26
	40	0.33
	50	0.40
	60	0.47
	70	0.54
fecal sample Pi,ppm		__________ sample estimated P %

Instructions for use- *The worksheet allows entry of farm information and relevant P content of soils, forage and free choice mineral. Dietary P requirements of beef cattle are provided for your convenience. If cattle receiving no additional feed or mineral supplementation, fresh forage or hay analysis are accurate indicators of P intake of cattle. If other feed or supplements are provided, collection of a fecal sample will allow estimation of the animal's dietary p intake. To estimate dietary P content simply insert the lab result for Inorganic P (Pi) in the shaded box above and the estimated diet content will appear in the blanl space to the right. This diet estimation can be compared to the table on the right to determine if it meet the animal's requirement for P.*